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(11)

**EP 1 022 803 A2**

(12)

**EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
26.07.2000 Bulletin 2000/30

(51) Int Cl.7: **H01Q 9/04**, H01Q 21/24,  
H01Q 21/06

(21) Application number: **99310446.2**

(22) Date of filing: **22.12.1999**

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU**  
**MC NL PT SE**  
Designated Extension States:  
**AL LT LV MK RO SI**

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(30) Priority: **22.01.1999 GB 9901298**

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**(54) Dual polarisation antennas**

(57) A dual polarisation antenna has a feed network comprising two feed channels 15, 16 which divide into feed lines 15a, 15b, 16a, 16b respectively coupled to

four slots 13a, 13b, 14a, 14b. The four slots are in registration with and couple to four patches 10a, 10b, 12a, 12b which are in turn coupled to a radiating coating 5.

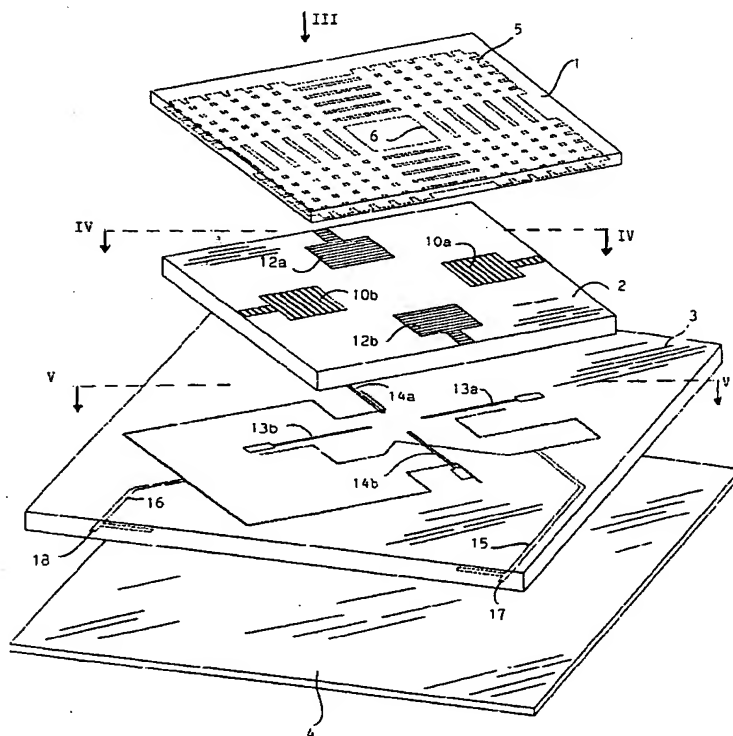


Figure 2

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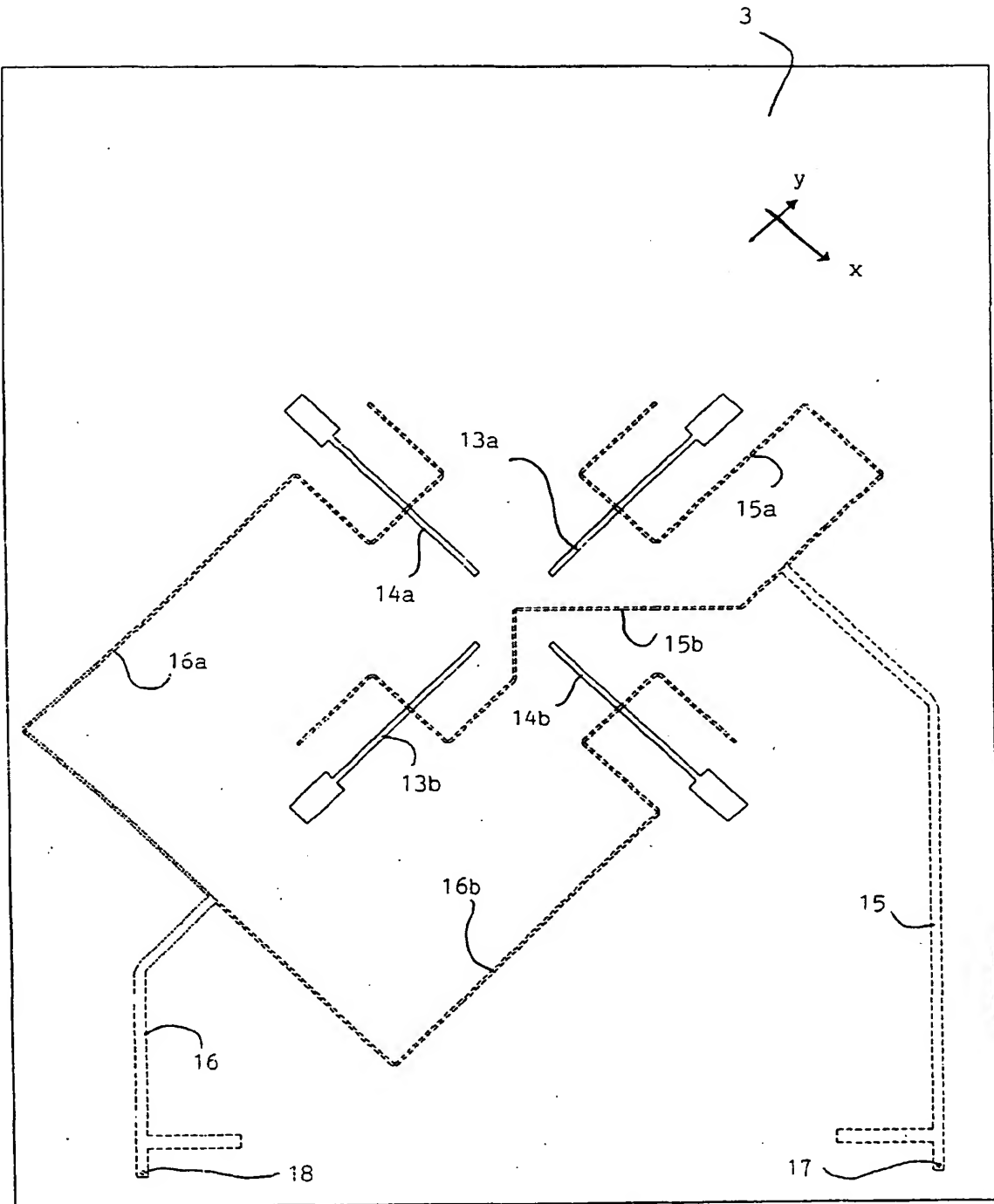


Figure 5

## Description

[0001] This invention relates to dual polarisation antennas.

[0002] With the ever-increasing demand for mobile voice and data communications in urban areas, there is a need for a wide-band antenna capable of transmitting and receiving dual polarised electromagnetic signals. Desirably, the antenna should be compact and have minimum visual impact on its surroundings. A considerable amount of work has been done in the field of dual polarisation antennas, and in particular the use of an aperture coupling technique to isolate the feed network from the radiating element. This arrangement allows a single radiating patch to be used in a dual polarisation antenna. The aperture coupling technique also has the potential of increasing the bandwidth of an antenna. However, these known antennas generally exhibit an unsatisfactory level of cross polarisation discrimination and the isolation between the two inputs of the two polarisations is low.

[0003] An aperture coupled patch antenna, in its standard configuration, utilises electromagnetic coupling between the feed network and the radiating patch. This configuration minimises the direct physical connections often required in patch antenna constructions. A coupling slot (sometimes referred to as an aperture) is formed in the ground plane of the feed network and via which signals from the feed network are electromagnetically coupled to the radiating patch located on the other side of the ground plane. A technique of placing an additional patch between the radiating patch and coupling slot is often used to increase the bandwidth of the antenna. The dimensions of the additional patch and its spacing between the radiating patch and the coupling slot have a significant effect on the antenna's characteristics and require careful adjustment in order to provide the optimum coupling and bandwidth.

[0004] In a dual polarised aperture coupled patch antenna, two coupling slots, which may be separated from each other or joined together to form a crossed shape, are normally used to provide the two excitations of the two polarisations. Signals from the two feed channels, which correspond to the two polarisations, are coupled to a radiating patch via the coupling slots respectively. The crossed shape coupling slot is commonly used despite its high cost requirement of using two individual dielectric layers for carrying the two feed channels. An alternative arrangement of using four individual coupling slots is sometimes used to minimise the requirement for two dielectric layers. This arrangement allows the two feed channels to be formed on the same side of a dielectric layer, and furthermore it effectively isolates the two feed channels and prevents them from crossing over each other as is often found in the crossed shape configuration. This improved isolation between the two feed channels reduces the overall cross couplings within the antenna structure.

[0005] According to the invention there is provided an antenna for transmission/reception of dual polarised signals, the antenna comprising a radiating/receiving member coupled to a feed/reception network by coupling means comprising four slots coupled to the network and four electrically conductive patches which are in respective registration with and coupled to the four slots and which are also coupled to the radiating/receiving member.

[0006] Hence, in the present invention, four individual coupling patches are used. Preferably the four coupling patches are all formed on the same side of a dielectric layer with a pattern which enhances the degree of isolation of the coupling mechanism. The coupling slots couple to both coupling patches and the member providing the radiating patch. The four coupling patches are also used to provide an additional resonance when they are coupled to the radiating patch. The resulting coupling mechanism is much different from that using a single patch as found in standard configurations. To further improve the cross polarisation discrimination of the antenna, the radiating patch may be formed with a grid pattern which restricts the current flow on the patch along only the two orthogonal directions corresponding to the two polarisations.

[0007] An antenna according to the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is an isometric view of the antenna,

Figure 2 shows the antenna with its components in exploded view,

Figure 3 is a plan view of the antenna, looking in the direction of arrow III in Figure 2, but with certain detail omitted for clarity,

Figure 4 is a view of the antenna on the plane depicted by the arrows IV-IV in Figure 2 but with certain detail omitted for clarity, and

Figure 5 is a view of the antenna on the plane depicted by the arrow V-V in Figure 2.

[0008] The antenna shown in the drawing is a wide-band low profile dual polarisation antenna capable of receiving and transmitting (either sequentially or simultaneously), dual polarised signals, ie signals polarised in mutually orthogonal planes. The antenna comprises a stack of three panels 1, 2 and 3 of dielectric material which are copper clad in pre-determined patterns on one or both surfaces, preferably by an etching process. The three panels 1, 2 and 3 are mounted on a supporting base panel 4 of aluminium.

[0009] The upper panel 1 has, on its lower surface, a copper coating 5 etched to leave a pattern of conducting metal area best illustrated in Figure 3. The coating 5 has

a square shape with a castellated outer edge and is 90° symmetric. At each of its four corners, the coating 5 has a square area covered by a regular array of square holes in the coating. Centrally within these four square areas is a cross-shaped area having a large square aperture 6 and four limbs 7a, 7b, 8a and 8b each occupied by an array of elongated apertures in the copper coating. The areas 7a, 7b are aligned and their elongated apertures extend parallel to one another in a first direction x parallel to one pair of edges of the panel 1. The areas 8a, 8b are aligned and have elongated apertures extending parallel to one another in a second direction y (orthogonal to the direction x) and parallel to the other pair of edges of the panel 1.

[0010] The panel 1 is held in spaced parallel relationship with respect to the panel 2 next beneath it by means of insulating spacers, in this case four support legs 9. The upper surface of the panel 2 has formed thereon four patches 10a, 10b, 12a, 12b formed by selective deposition or etching of copper in the pattern best illustrated in Figure 4. Each patch has a main rectangular area formed by a parallel array of nine closely spaced copper strips and a subsidiary rectangular area formed by four copper strips. The four patches are symmetrically arranged on the square surface area of the panel 2, with the two patches 10a, 10b having their copper conductors extending in the direction x and the two patches 12a, 12b having their copper conductors extending in direction y. Moreover, the four patches 10a, 10b, 12a, 12b underlie and are in vertical registration with the four areas 7a, 7b, 8a and 8b respectively.

[0011] The lower surface of the square panel 2 abuts the upper surface of the rectangular panel 3, in the angular orientation best illustrated in Figure 4, ie with the edges of the panels 1 and 2 at 45° with respect to the edge of the panels 3 and 4. The upper surface of the panel 3 is copper clad, save for four uncoated slots 13a, 13b, 14a, 14b. As best shown in Figure 5, each slot has a relatively narrow inner part and a relatively wider but shorter outer part. The slots 13a, 13b are aligned along the y axis and the slots 14a, 14b are aligned along the x axis. Further, the slots 13a, 13b lie symmetrically below and in registration with the patches 10a, 10b and the areas 7a and 7b. Similarly, the slots 14a, 14b lie symmetrically below and are in registration with the patches 12a, 12b and the areas 8a, 8b.

[0012] The lower surface of the panel 3 has a feed/reception network comprising two channels 15 and 16 each terminating adjacent the panel in a respective terminal 17 or 18. The channels 15 and 16 are formed by copper paths on an otherwise uncoated panel surface. The channel 15 divides into two separate feed lines 15a, 15b. The feed line 15a leads towards the slot 13a (but on the opposite surface of the panel 3), crossing beneath the line of the slot 13a at right angles thereto and terminating in an open circuit. The feed line 15b similarly crosses below the line of the slot 13b at right angles thereto and terminates in an open circuit. The channel

16 divides into two feed lines 16a, 16b, respectively crossing beneath the slots 14a, 14b at right angles thereto and terminating in open circuits. In a similar manner to the feed lines 15a and 15b.

[0013] The assembly of panels 1, 2 and 3 is supported on the support base panel 4 by means of a plurality of supports 19 to provide a compact slab-like construction of antenna typically having a length of 220mm a width of 180mm.

[0014] In use as a transmitting antenna, input signals are applied to the terminals 17, 18, with signals polarised in one plane being applied to the terminal 17 and signals polarised in the orthogonal plane being applied to the terminal 18. The input signals are conducted along the feed channels 15 and 16 to the conducting feed lines 15a, 15b, 16a, 16b. Each feed line (on the lower surface of the panel 3) extends across a corresponding coupling slot (on the upper surface of the panel 3), the length of feed line extending beyond the corresponding slot forming an open circuit tuning stub which is set to be approximately equal to one quarter of the guided wavelength at the desired frequency. The dimensions of each coupling slot and open circuit tuning stub are selected for best impedance matching and coupling. The correct phasing synchronisation between the coupling slots is achieved by adjustment of the electrical length of each feed line. Thus, the four coupling slots 13a, 13b, 14a, 14b effectively minimise cross couplings and interactions between the two feed channels 15 and 16. The widened end of each coupling slot provides further broad band tuning for the antenna.

[0015] By means of the coupling slots, signals from the feed channels 15 and 16 are coupled to the radiating coating 5 through the intermediary of the coupling patches 10a, 10b, 12a, 12b. The grid pattern of the patches 10a, 10b, 12a, 12b restricts the flow of surface currents to the directions of polarisation. The separated patches 10a, 10b, 12a, 12b minimise cross coupling between the two polarisations while providing the desired broadband coupling between the slots 13a, 13b, 14a, 14b and the radiating coating 5. The relative permittivity and thickness of the dielectric layer 2, together with the dimensions of the four patches 10a, 10b, 12a, 12b, are selected for optimal broadband tuning and coupling to the coating 5.

[0016] The signals are thus coupled to the radiating patch provided by the coating 5. This is shaped and dimensioned such that surface currents resonate at the desired frequency along the two orthogonal directions of polarisation, as a consequence of its being mounted at the necessary spacing above the dielectric layer 2 by means of the supports 9. The pattern of the coatings, with its square apertures in the corners and elongated slots over the areas 7a, 7b, 8a, 8b, restricts and controls the flow of surface current along the two orthogonal directions and thus suppresses unwanted resonant components.

**Claims**

1. An antenna for transmission/reception of dual polarised signals, the antenna comprising a radiating/receiving member coupled to a feed/reception network by coupling means comprising four slots coupled to the network and four electrically conductive patches which are in respective registration with and coupled to the four slots and which are also coupled to the radiating/receiving member. 5  
10
2. An antenna according to claim 1, wherein the patches comprise one pair of patches having an array of electrically conducting strips extending in parallel relationship in a first direction and another pair of patches each having an array of electrically conducting strips extending in parallel relationship in a second direction orthogonal to said first direction. 15
3. An antenna according to claim 2, wherein the patches are formed on the surface of a dielectric layer which is in close or abutting relationship with a further dielectric layer bearing the slots. 20
4. An antenna according to claim 3, wherein the feed/reception network comprises two channels, namely a first channel which feeds signals to or receives signals from an aligned pair of the slots and a second channel which feeds signals to or receives signals from the other aligned pair of slots. 25  
30
5. An antenna according to any of the proceeding claims wherein the radiating/receiving member comprises an electrically conducting layer having a square or substantially square outer periphery, with apertured corner areas and four slotted areas. 35  
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6. An antenna according to claim 5, wherein the four slotted areas in the layer are in respective registration with the four patches. 45  
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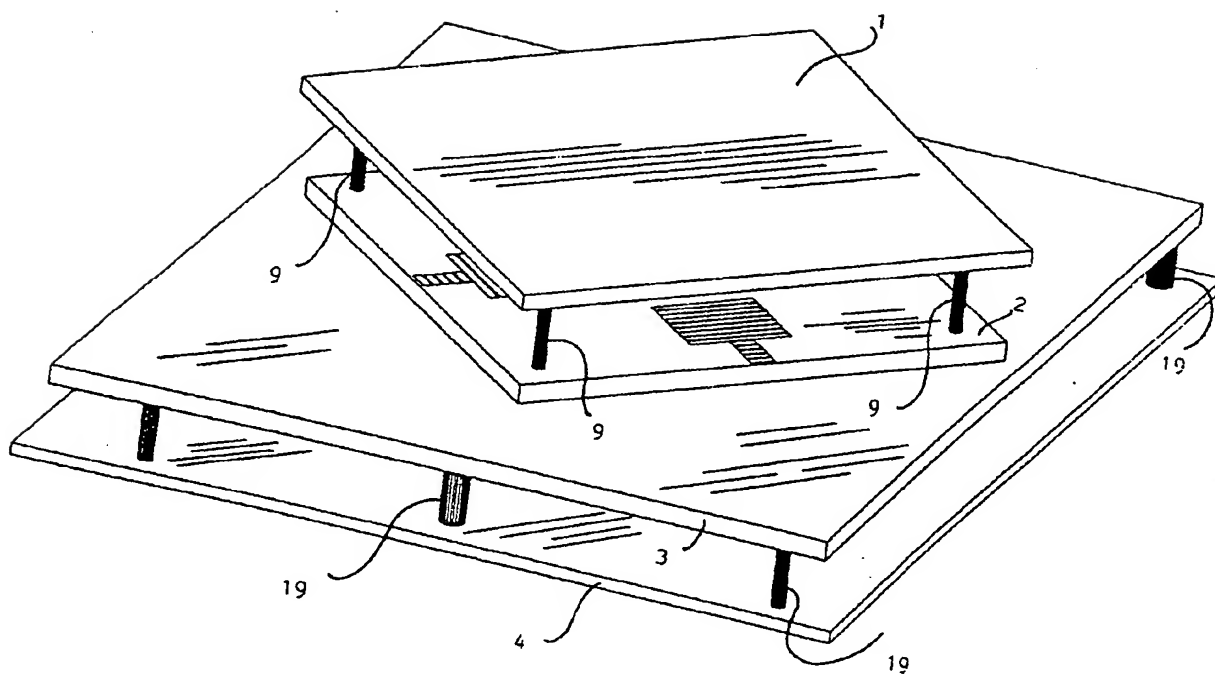


Figure 1

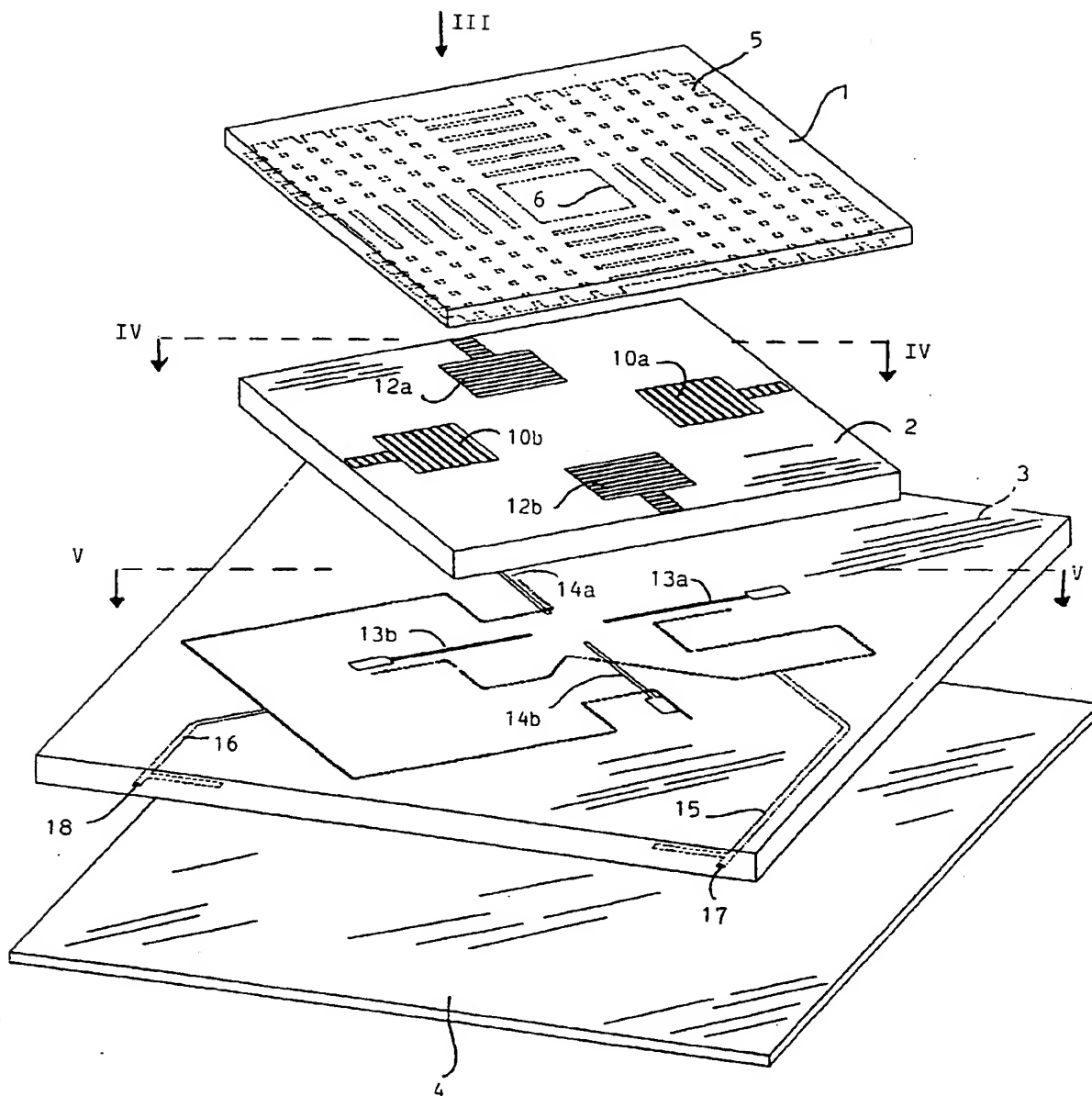


Figure 2

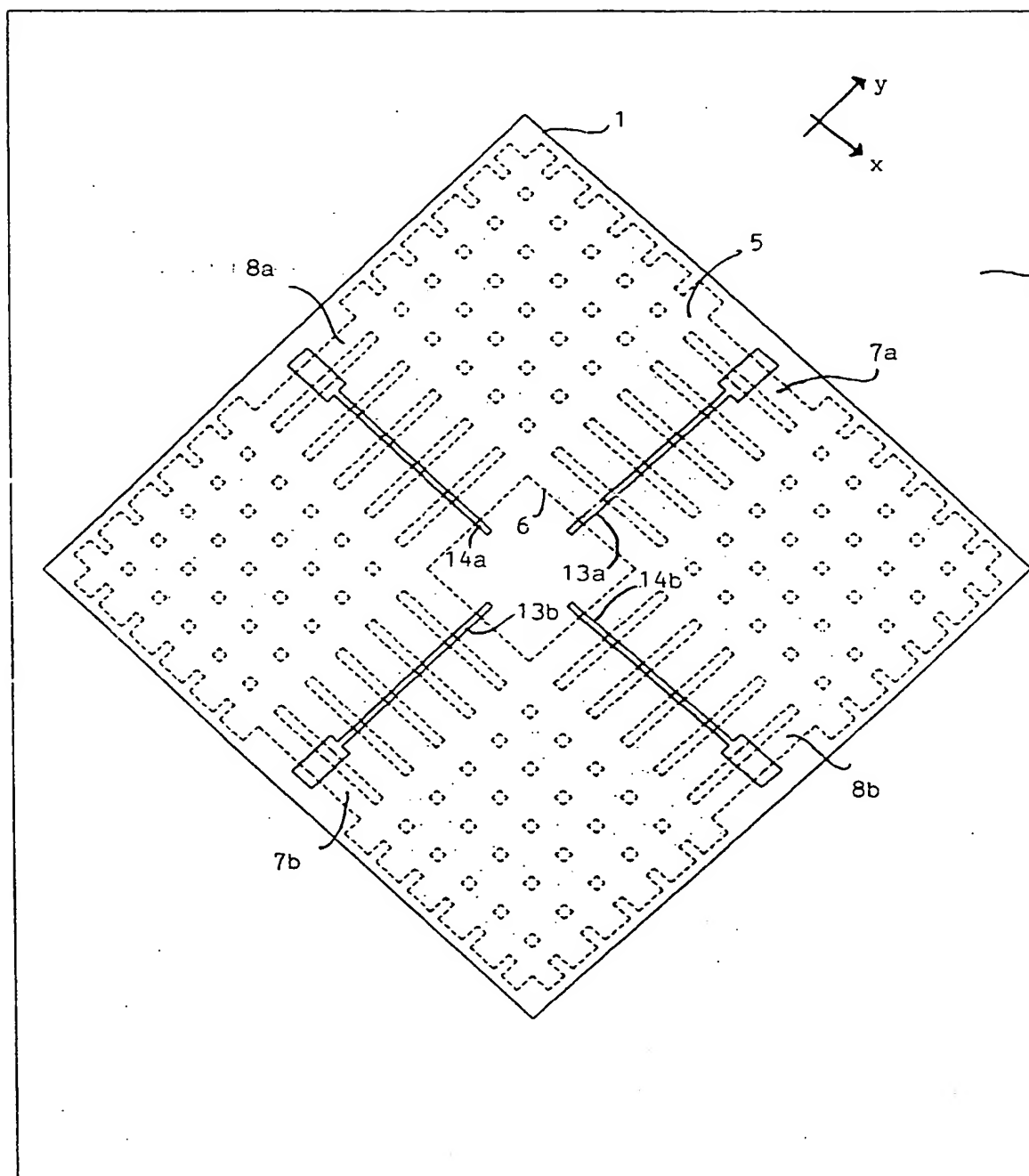


Figure 3

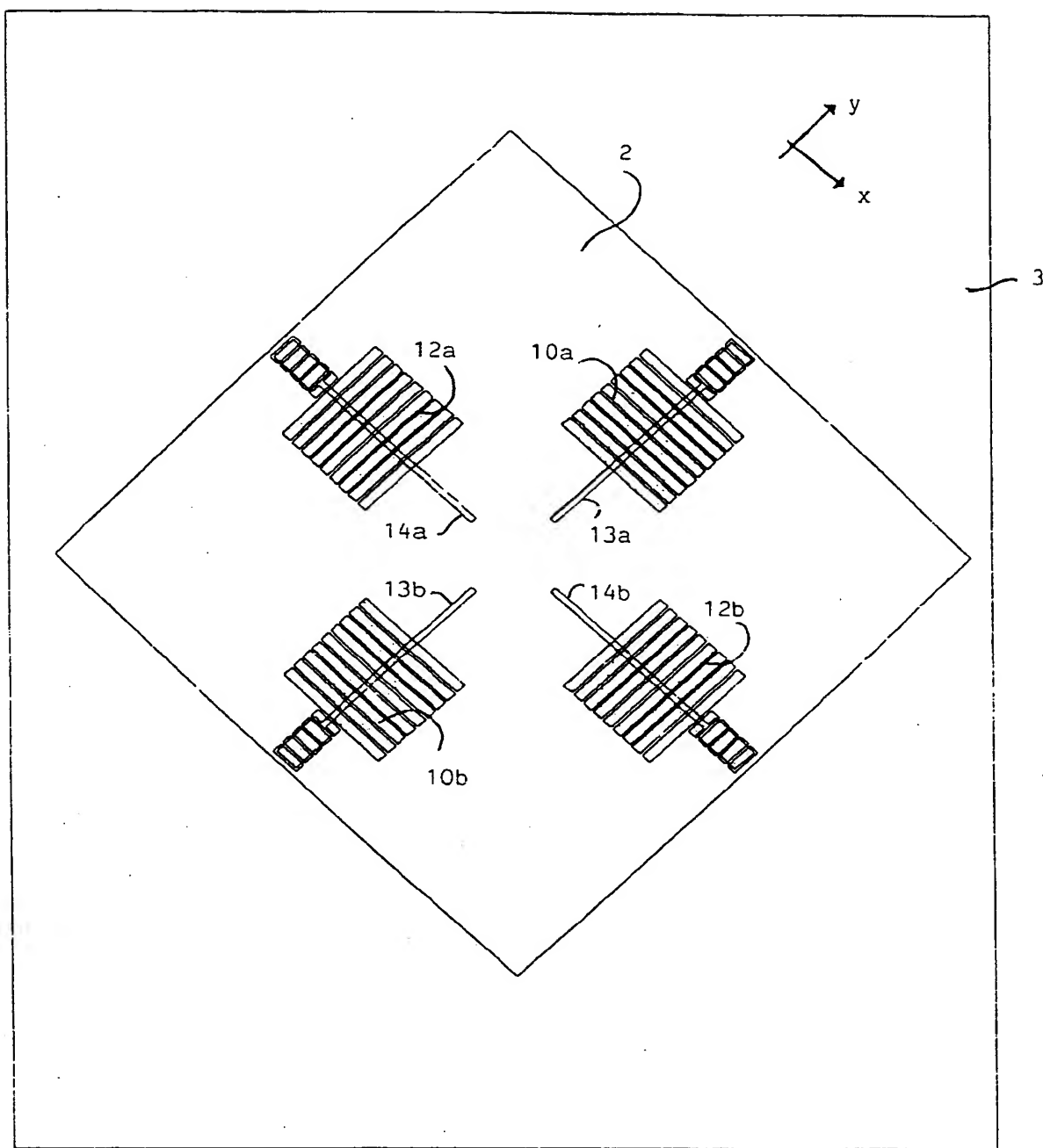


Figure 4

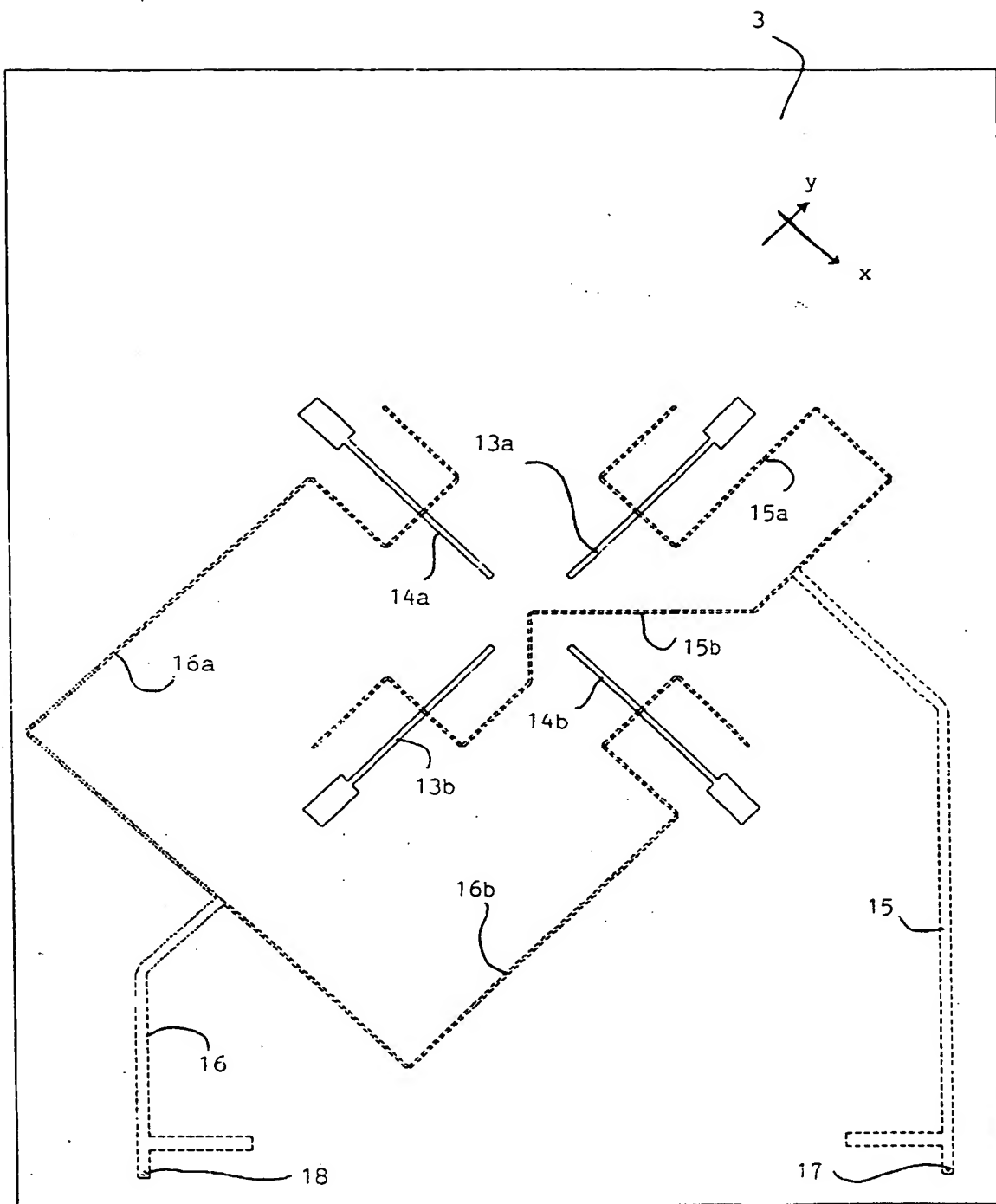


Figure 5

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(11)

**EP 1 022 803 A3**

(12)

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(88) Date of publication A3:  
11.07.2001 Bulletin 2001/28

(51) Int Cl.7: **H01Q 9/04**, H01Q 21/24,  
H01Q 21/06

(43) Date of publication A2:  
26.07.2000 Bulletin 2000/30

(21) Application number: 99310446.2

(22) Date of filing: 22.12.1999

(84) Designated Contracting States:  
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU  
MC NL PT SE**  
Designated Extension States:  
**AL LT LV MK RO SI**

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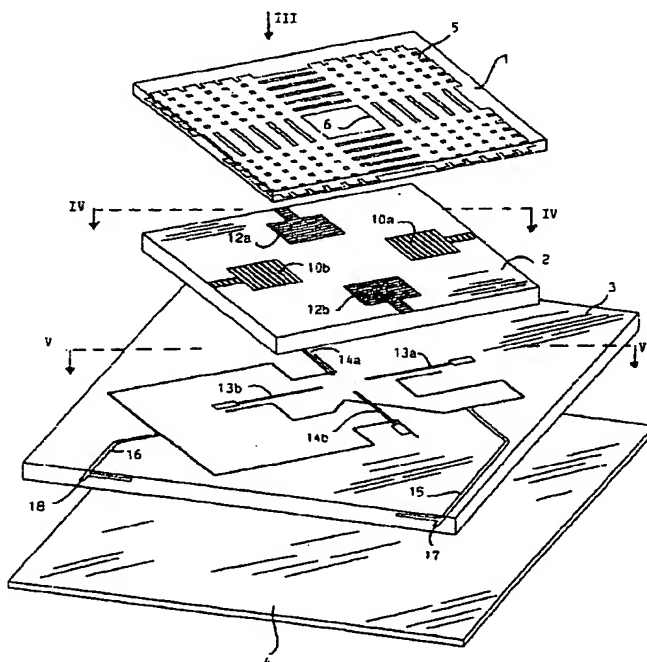


Figure 2

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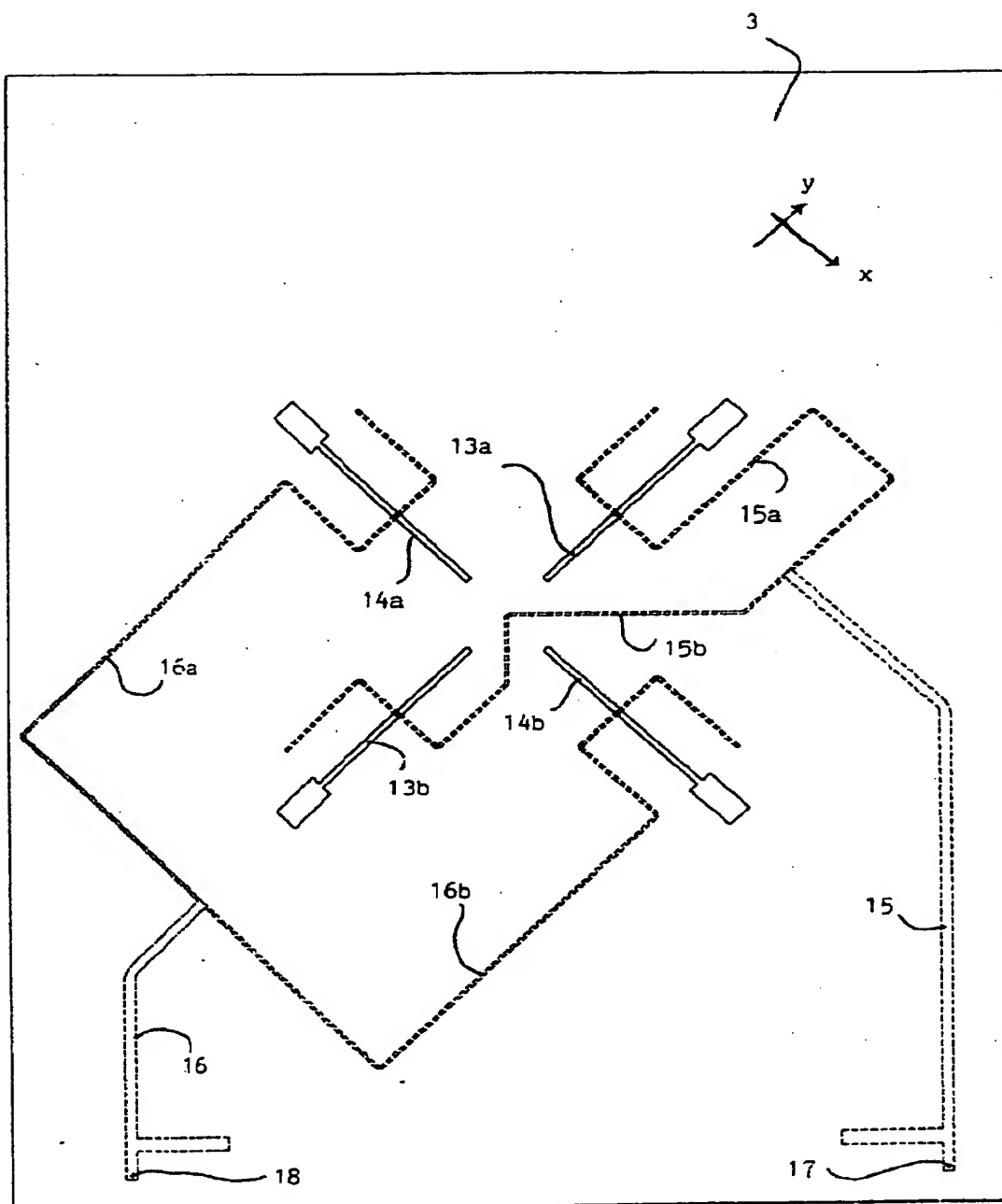


Figure 5



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# EUROPEAN SEARCH REPORT

Application Number  
EP 99 31 0446

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 4 903 033 A (TSAO CHICH-HSING ET AL) 20 February 1990 (1990-02-20) * column 3, line 57 - column 7, line 16; figures 1-6 *	1	H01Q9/04 H01Q21/24 H01Q21/06
A	----- GARDIOL F E ET AL: "BROADBAND PATCH ANTENNAS - A SSFIP UPDATE" IEEE ANTENNAS AND PROPAGATION SOCIETY INTERNATIONAL SYMPOSIUM,US,NEW YORK, IEEE, 21 July 1996 (1996-07-21), pages 2-5, XP000782134 ISBN: 0-7803-3217-2 * page 3-4 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			H01Q
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>16 May 2001</b>	Examiner <b>Ribbe, J</b>
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document	
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**ANNEX TO THE EUROPEAN SEARCH REPORT  
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4903033 A	20-02-1990	NONE	

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